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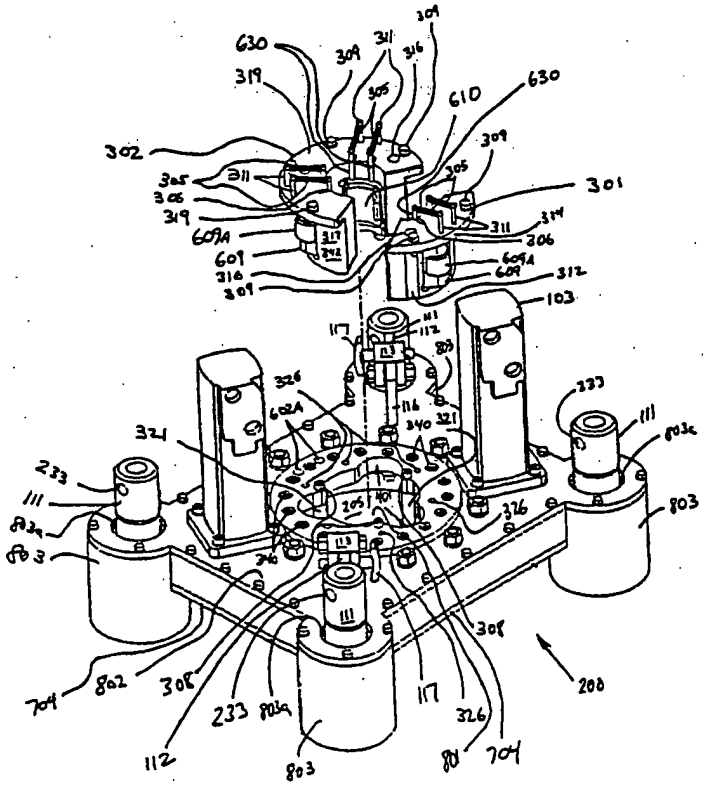
(54) Title: CLOSED-HEAD POWER TONGS

(57) Abstract: Closed head power tongs (200) used to make up and break threaded pipe joints are disclosed herein. The closed head power tongs (200) have removable mating inserts (301, 302) that allow the gripping aperture (205) of the power tongs (200) to be increased so that objects larger than the gripping diameter of the tongs (200) can be raised or lowered through the center aperture (801) of the power tong (200) without removing the tongs from alignment with the drill string (120).



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CLOSED-HEAD POWER TONGS

BACKGROUND OF INVENTION

Technical Field

The present invention relates to power tongs typically used in the oil and gas industry to make up and break apart threaded joints on pipe, casing, and similar tubular members.

Background Art

Power tongs have been used for many years and are generally employed in the oil and gas industry to grip and rotate tubular members, such as tubular. The tubular members are gripped with high compressive forces while applying a high degree of torque to break apart or tighten threaded tubular member connections. In most cases, power tong designs employ a cam mechanism for converting a portion of the torque into a gripping (compressive) force normal to the tubular member. This conversion is often accomplished using a power-driven ring gear having an interior cam surface. As the ring gear rotates, cam follower (roller) on a jaw member rides upon the cam surface, causing the follower (and thus the jaw member) to move into contact with the tubular member. U.S. Patent Number 4,404,876 discloses such an arrangement.

Most current power tong designs include a ring gear cam with an open slot or throat ("open-throat power tongs"), through which the tubular member passes to position the jaw members around the tubular member. However, some tong designs employ a ring gear cam that has no open throat and is thus a solid circular member. This solid circular ring gear design is generally referred to as a closed-head power tong.

When the drilling environment allows the use of a derrick or similar overhead structure from which a power tong may be suspended, an open-throat power tong is often a more efficient tool. Open-throat power tongs easily disengage and/or retract from the tubular member when the operator desires to raise, lower, or otherwise manipulate the tubular member.

On the other hand, a closed-head power tong is more difficult to retract from the tubular member because it has a closed throat and must pass over the end of a tubular member. However, there are common drilling environments where there is no structure from which an

open-throat power tong may be suspended and insufficient workspace to engage and retract open-throat power tongs. In such environments, a closed-head power tong may be the only practical alternative. Closed-head power tongs are highly useful during operations where snubbing units are employed.

Typically, closed-head power tongs are positioned over the drill string with the individual tubular members forming the drill string extending through a center aperture in the closed-head power tong. A tubular member is moved vertically through the center aperture until the threaded joints for connecting adjacent tubular members are in position to be made up (screwed together) or broken out (unscrewed).

To increase efficiency, as many successive tubular member connections as possible are made-up or broken out without interruption, i.e. having to move the center aperture of the tong out of alignment with the drill string. However, the drill string may include a down hole tool or other device that has a diameter greater than the diameter of the center aperture of the closed-head power tong. In these situations, the prior art closed-head power tongs typically require that the drill string be broken and any tubular positioned in the center aperture at that point be removed therefrom. The closed-head power tongs are then removed from alignment with the drill string, and the oversized tool is removed from the drill string or re-positioned vertically along the drill string above or below the power tong such that it is not required to pass through the power tong. The closed-head power tong can then be re-aligned with the drill string. To re-establish the connection of the drill string through the center aperture, the unconnected tubular joint must be positioned above or below the center aperture to reconnect to a continuous length of drill string.

What is need in the art is a closed-head power tong design which allows the center aperture to be readily increased in diameter without the necessity of removing the drill string from the center aperture. The closed-head power tong design should provide for center aperture enlargement with a minimum lost time and with such simplicity that unskilled workers could perform the task.

OBJECTS OF THE INVENTION

With the aforementioned considerations in mind, it is therefore an object of this invention to provide a power tong assembly used in connection with a conventional snubbing unit.

It is a further object of the present invention to provide a closed head power tong that is adapted to increase the gripping aperture therein to allow passage of objects having a diameter larger than the normal gripping aperture.

It is a further object of the present invention to provide a closed head power tong that may be quickly and efficiently operated without the necessity of removing the power tong from alignment with the drill string.

The invention herein comprises a closed head power tong having a power tong body. The tong body has a ring gear positioned within the body, and the ring gear comprises at least one cam surface. The tong body also has a cage plate assembly comprising at least two mating inserts and a jaw aperture formed in at least one of the mating inserts.

The invention may also comprise a power tong body having a ring gear positioned within the body wherein the ring gear has at least one cam surface. A cage plate assembly is removably positioned at least partially within the body and configured to have a gripping aperture therein. The gripping aperture has first dimension and the cage plate assembly is adapted to increase the gripping aperture to a second dimension sufficiently sized to allow passage of an object having a dimension larger than the first dimension.

A method of making up or breaking one or more section of tubular members using the closed head power tong invention is also disclosed herein. The method comprises the steps of (a) removing the cage plate assembly from the power tong body, thereby increasing the diameter of the gripping aperture to allow passage of a tool; and (b) passing the tool through the power tong body a sufficient distance so that the cage plate assembly may be repositioned within the power tong body.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a side view of the invention employed in a conventional snubbing unit.

Figure 2a illustrates a side view of the invention.

Figure 2b illustrates an upper perspective view of the invention with the top plate removed.

Figure 2c illustrates a cross-sectional view of the spring assembly used to mount the power tong to the leg assembly.

Figure 2d illustrates a side view of the link assembly that mounts the power tong to the leg assembly.

Figure 3 illustrates an upper perspective view of the mating inserts inserted within the upper cage plate shown without the jaw assemblies positioned in the jaw apertures. The lower cage plate is not shown.

Figure 4 illustrates a lower perspective view of the mating inserts inserted within the upper cage plate shown without the jaw assemblies positioned in the jaw apertures. The lower cage plate is not shown.

Figures 5a and 5b illustrate an embodiment of the mating inserts shown attached (Figure 5a) and detached (Figure 5b).

Figures 5c and 5c illustrate another embodiment of the mating inserts shown attached (Figure 5c) and detached (Figure 5d).

Figures 6a and 6b illustrate embodiments of the ring gear with three camming surfaces engaging the jaw assemblies.

Figure 7 illustrates an upper view of the power tong with the upper tong plate and upper cage plate removed.

Figure 8 illustrates an upper view of the power tong with the cage plate assembly removed.

Figures 9a and 9b illustrate embodiments of the back-up used in combination with the present invention.

Figure 10 illustrates a cross-section view of the interrelation of the upper and lower cage plates, the ring gear, and the mating inserts taken along the A-A axis shown in Figure 3.

Figure 11 illustrates an exploded view of the invention shown with the mating inserts removed from within the power tong.

Figure 12 illustrates a partial bottom view of the power tong showing the brake band's engagement with the brake ring.

BEST MODE FOR CARRYING OUT THE INVENTION

Illustrations of construction, design, and methods of operation of the invention are set forth below with specific references to the Figures. However, it is not the intention of the inventor that the scope of his invention be limited to these embodiments.

Figure 1 illustrates the application of the power tong-back-up combination **100** used in connection with a snubbing unit **101** positioned over an existing well. Snubbing unit **101** is equipped with slip assemblies **160, 170** that are used in conjunction to raise and lower tubular members **110, 120** as is known in the art. Snubbing unit **101** may also be equipped with a hydraulic rotary table **180** that rotates equipment positioned thereon.

When lengths of tubular members are joined ("made-up") or disconnected ("broken"), tubular members **110, 120** are passed through the respective gripping apertures **205, 901** (shown in Figure 2b) in power tong **200** and back-up **300**. When joint **130** (as seen in Figure 1) is suitably positioned between power tong **200** and back-up **300**, power tong **200** engages and grips first tubular member **110** and a back-up **300** engages and grips second tubular member **120**. Power tong **200** rotates first tubular member **110** and back-up **300** grips and holds stationary second tubular member **120**. Pipe joint **130** is made-up or broken, depending upon the direction of torque applied to first tubular member **110** by power tong **200**.

Referring to Figure 2b, closed-head power tongs **200** have a power tong body composed of lower plate **704** and an upper plate **802**, both having a center aperture **801** passing

therethrough as shown in Figures 7 and 8. Figure 8 illustrates upper plate **802** and motors **103** operatively positioned thereon. A collar **803** having leg apertures **803a** is positioned at each corner of upper plate **802** to assist in the mounting and operation of power tong **200** on leg assembly **102** as described below and shown in Figure 2b. Figure 7 illustrates how motors **103** rotate respective gears **701**, providing rotational energy to ring gear **600** through interaction of teeth **702** and teeth **601**.

Referring back to Figure 1, top plate **104** is positioned atop leg assembly **102** and fixes the position of legs **102a** relative to each other. Top plate **104** has a passageway **107** extending therethrough substantially aligned with gripping apertures **205, 901**. Optionally, a tapered pipe inlet **105** is positioned atop top plate **104** and passageway **107** to guide tubular members **110, 120** into closed-head power tong **200** when tubular member **110, 120** are inserted into a well. As shown in Figures 2a and 4, a pipe inlet **402** is attached to mating inserts **301, 302** to guide tubular member **110, 120** into center aperture **801** in power tong **200** when tubular members **110, 120** are raised from a well.

Figure 9a illustrates back-up **300**, which comprises a body having a lower section **910**, a cover **920** (shown in Figure 9b) and two or more, preferably three, hydraulically powered jaw assemblies **904** positioned therein. As shown in Figure 9a, jaw assemblies **904** have jaw carriers **903** with jaws **902** facing back-up power tong gripping aperture **901** through which tubular members pass. Jaw assemblies **904** are very similar to the jaw assemblies found in U.S. Patent No. 4,649,777 to Buck, which is incorporated herein by reference. Back-up **300** mounts onto leg assembly **102** via apertures **905** that correspond to each leg **102** substantially as shown in Figure 2b.

Referring to Figure 1, closed-head power tong **200** and closed-head back-up **300** are positioned on snubbing unit **101** using leg assembly **102** that allows relative vertical displacement of the power tong unit **100**. As seen in Figure 2b, power tong **200** locks onto legs **102a** using spring assembly **106** (shown in Figures 2c and 2d) or any other suitable member known in the art. Viewing Figure 2c, each spring assembly **106** comprises a spring tube

230 positionable over one leg 102a. Spring tube 230 has a first end 270 comprising a collar 111 and a second end 249. Spring tube 230 is fixedly positioned relative to leg 102a using a nut 232, washer 232a, and bolt 231. Bolt 231 inserts coaxially through bolt passageway 233 in spring tube 230, through holes 240 in leg 102a, through the other side of bolt passageway 233, through washer 232a, and into nut 232. As also shown in Figure 2d, the lower edge 251 of end 270 (collar 111) provides a shoulder against which first end 238 of spring cap 235 rests.

The second end 249 of spring tube 230 has threads 247 that mate with corresponding threads 248 on spring retainer 246. The upper edge 256 of spring retainer 246 provides a shoulder upon which the first end 243 of spring cap 242 may rest. Spring 250 is positioned between shoulder 237 of spring cap 235 and shoulder 245 of spring cap 242. Upper power tong plate 802 is positioned above and may rest upon spring plate lip 236 so that the weight of power tongs 200 may be supported in part by each of the four spring assemblies 106 and so that spring 250 biases spring cap 235 and upper plate 802 away from end 249.

As power tong 200 grips and rotates first tubular member 110 and back-up 300 grips and holds stationary second tubular member 120, first tubular member 110 is either forced toward or away from second tubular member 120 by action of the corresponding threads at joint 130 on tubular members 110, 120. The construction and design of spring assemblies 106 allow power tong 200 to move vertically to accommodate the vertical motion of the tubular members 110, 120.

When a joint 130 is made-up, first tubular member 110 moves toward second tubular member 120. Accordingly, power tongs 200 move downward. Upper tong plate 802, already in contact with lip 236, forces spring cap 235 to compress spring 250. Note that in an "at rest" position, upper tong plate 802 rests upon lip 236 due to gravity. When the make up is complete and the jaw dies 610 release tubular member 110, the potential energy of spring 250 forces upper plate 802 (and hence power tong 200) back to its normal position.

When a joint 130 is broken, first tubular member 110 moves away from second tubular member 120. Accordingly, power tongs 200 move upward. Lower tong plate 704 moves

upward and abuts lip 244, causing spring cap 242 to compress spring 250. When the joint 130 is broken and jaw dies 610 release tubular member 110, the potential energy in spring 250 forces lower plate 704 (and hence power tong 200) back to its normal position.

Referring to Figure 2d, links 106A movably attach power tong 200 to two of legs 102a via collar 111, spring tube 230 and spring assembly 106. Each of these legs 102a is configured with one or more holes 240 that allow bolt 231 to insert through holes 233 in collar 111 and through holes 240 in leg 102a. Bolt 231 fixedly positions collar 111 relative to leg 102a.

Each link 106A comprises a first arm 112 that connects to collar 111 and a second arm 116 that connects to upper tong plate 802 (see Figure 2b). Each arm 112, 116 connects to a third arm 113 which allows arm 112 to move vertically relative to arm 116, allowing power tong 200 to move vertically relative to legs 102a as previously discussed. A locking pin 117 (shown in Figure 2b) may be inserted through either pivot hole 114, 115 to prevent vertical displacement of power tong 200 by preventing third arm 113 from pivoting. Links 106A also help prevent the small amount of rotational movement that can occur by power tong 200 relative to legs 102a. It is generally desirable to engage locking pin 117 when power tong 200 is being transported or handled to prevent unexpected movement between power tong 200 and back-up 300 from injuring workers or damaging equipment.

Referring to Figure 10, cage plate assembly 204 generally comprises annular upper and lower cage plates 203, 202. Figure 3 is a perspective view showing upper cage plate 203 but having lower cage plate 202 removed. While the following description refers primarily to Figure 10, cross-reference to Figure 3 will aid in understanding the subject matter discussed. Rollers 710 sit within power tong 200 and mount on shafts 711, which are held in place by nuts 712. Rollers 710 support ring gear 600 by supporting ring gear teeth 601 therewithin. Ring gear 600 is positioned between lower and upper cage plates 202, 203 using cam followers 330 mounted from respective plates 202, 203, with nuts 331 positioned in corresponding apertures 340, 341.

Cage plates 202, 203 are appropriately spaced using spacer tube 321, as seen in Figure 10, so that ring gear 600 and plates 202, 203 may freely rotate relative to one another. Cage plates 202, 203 are fixedly positioned relative to each other using a bolt 308 inserted through aperture 320 in upper cage plate 203, through spacer tube 321 and into bolt hole 324 in lower cage plate 202.

Viewing Figures 6a and 6b, ring gear 600 also has one or more cam surfaces 607 that face jaw assemblies 609. The rotation of ring gear 600 about the jaw assemblies 609 causes engagement and retraction of the jaw assemblies 609 (and jaw dies 610 thereon) with the tubular member as rollers 609A roll upon cam surfaces 607. Causing jaws 610 to ride upon cam surfaces 607 requires relative rotation between ring gear 600 and cage plates 202, 203 attached to mating inserts 301, 302, which in turn carry jaw assemblies 609. For example, see U.S. Patent No. 4,404,876 to Eckel or 5,291,808 to Buck, which are incorporated by reference herein. A preferred jaw assembly 609 used with the present invention is a low friction jaw assembly such as that disclosed in U.S. Patent No. 5,819,605 to Bangert, et al.

To allow initial relative rotation between ring gear 600 and cage plates 202, 203, a brake band 1125 (see Figure 12) typically applies a limited frictional force to cage plate 202 and allows ring gear 600 to rotate relative to the cage plates 202, 203 until jaws 610 engage the tubular member. Cage plates 202, 203 and ring gear 600 then rotate in unison, thereby applying torque to the tubular member.

Jaw assemblies 609 are shown retracted in Figure 6a and engaged in Figure 6b with mating inserts 301, 302 not shown. The lines denoted as 620, 621 show the minimum and maximum retraction and extension points of jaw dies 610.

Viewing Figure 12, to initially hold cages plates 202, 203 stationary while ring gear 600 rotates sufficiently to close jaw dies 610, a brake band 1125 acts upon lower cage plate 202. In the embodiment shown, brake band 1125 actually contacts brake ring 1205, which acts as an extension of cage plate 202 as best seen in Figure 10. Brake band 1125 applies an initial frictional force to lower cage plate 202 through brake ring 1205, holding cage plates 202, 203

stationary and allowing ring gear **600** to move relative to cage plates **202, 203**. Generally, it is desirable to make brake band **1125** adjustable such that it may be tightened or loosened in order to vary the amount of frictional force applied to cage plate **202**.

After relative rotation begins, jaw assemblies **609** mount cam surfaces **607** via jaw rollers **609A** and close on the tubular. After closing on the tubular, ring gear 600 continues to transfer torque to jaw assemblies **609** and therefore to cage plates **202, 203** eventually causing cage plate **202** to overcome the resisting frictional force of brake band **1125**. Because cam surfaces **607** translate torque into radial force, a higher torque needed to overcome the resistance of brake band **1125** results in a higher initial radial force being placed on the tubular prior to cage plates 202, 203 beginning to rotate. Therefore, the frictional resistance of the brake band **1125** is adjusted to regulate the initial radial load or initial "bite" with which jaw assemblies **609** grip the tubular.

The embodiment of brake band **1125** as shown in Figure 12 is similar to the brake band disclosed in United States Patent Application Serial No. 08/897,185, which is incorporated herein by reference. Brake band **1125** is biased against brake ring **1205** using a spring **1134**. Spring **1134** pivotally connects to brake arm **1111**. Spring **1134** also pivotally connects to power tong lower plate **704** using spring retainer **1138** and pivot pin **1139**. Brake band **1125** constantly maintains frictional resistance between brake band **1225** and brake ring **1205** during the entire operating sequence of power tong **200**.

As best seen in Figure 11, positionable within the annulus of cage plate **203** (hence within center aperture **801**) are at least two mating inserts **301, 302**, preferably only two as shown in Figure 5d. Viewing Figure 5d, mating inserts **301, 302** also have an upper lip **314** that rests upon the upper surface **318** of plate **203** (as shown in Figures 3 and 10). Mating insert sidewalls **317** extend downward from lip **314** and into center aperture **801** as seen in Figure 11.

As shown in Figure 5d, one or more apertures **316** are positioned within the upper surface **318** of inserts **301, 302** and extend through lip **314**. Apertures **316** allow upper cage

plate 203 and lower cage plate 202 to be fixedly positioned relative to each other via bolts 308 and spacer tube 321 as seen in Figure 10.

Referring to Figure 10, one or more bolts 308, having a threaded lower end 324 extend through inserts 301, 302 (via bore 320 in upper cage plate 203) through spacer tube 321 and into bolt bore 324 in lower cage plate 202. Bolt 308 inserts completely within aperture 316 so that inserts 301, 302 may be removed from center aperture 801 (as seen in Figure 11) without removing bolt 308. Because aperture 316 is configured only slightly larger than the head of bolt 308, the head of bolt 308 is configured with an internal engagement surface (shown in Figure 10) to allow a tool, such as an Allen wrench, to engage and remove or install bolt 308. Alternatively, aperture 316 may be sized sufficiently so that a conventional wrench may engage the perimeter of the head of bolt 308.

One or more connecting members 309, such as bolts and associated washers (shown in Figures 3 and 10), connect inserts 301, 302 to upper cage plate 203 via bolt hole 326 so that upper and lower cage plates 203, 202 and inserts 301, 302 may rotate concurrently.

Figure 11 illustrates a unit having three jaw assemblies 609. Viewing Figures 4, 5a and 5b, sidewall(s) 317 are configured to have jaw apertures 307 extending therethrough to allow jaw assemblies 609 (also shown in Figures 6a and 6b) to be positioned therein with the jaw dies 610 facing gripping aperture 205. Viewing Figure 11, each jaw 610 is biased in an retracted position using jaw springs 305 connected between pins 311 (best seen in Figure 3) and the upper stems 630 on jaw assemblies 609. Stems 630 slide within notches 306 formed in upper wall 319. Notches 306 aid in biasing jaw assemblies 609 in a retracted position.

As shown in Figure 4, mating inserts 301, 302 have recesses 312 formed in sidewalls 317. Spacer tubes 321 (not shown in Figure 4, see Figure 10) fit into recesses 312 so that cage plates 202, 203 may be operatively connected by bolt 308. Each jaw aperture 307 has a corresponding recess 401 formed in the lower portion 408 of cage plate 203 to allow jaw assembly 609 to be lifted from within cage plate 203 as seen in Figure 11.

Pipe inlet 402 is attached to the lower end 315 of mating inserts 301, 302 and may itself comprise mating sections 410, 411 that form inlet 402 when mating inserts 301, 302 are mated. Sections 410, 411 attach to lower end 315 using any suitable means, preferably using one or more bolts 406. Inlet 402 has a tapered sidewall 403 that converges from lower end 404 to upper end 405 to assist tubular members entering gripping aperture 205. The converging sidewall 403 is also shown in Figure 10.

Viewing Figure 10, insert sidewalls 317 have a pin hole 322 configured therein having an opening 327 in the outer surface 342 of sidewall 317 facing spacer tube 321. Bolt 406 has a hole therein that allows pin 323 to slide within hole 322 and through the hole in bolt 406. When inserts 301, 302 are positioned within center aperture 801, spacer tube 321 prevents pin 323 from disengaging bolt 406, preventing inlet 402 from detaching from inserts 301, 302.

Figures 5a and 5b illustrate one embodiment of mating inserts 301, 302 used in cage plate assembly 204. Figure 5a illustrates the mating inserts 301, 302 removed from cage plate assembly 204 and removed from within center aperture 801 in power tong 802. Viewing Figure 5b, insert 302 comprises at least one male mating member 501, more preferably male mating members 501, 502 positioned at each mating side 505 of insert 301. Male mating members 501, 502 engage and abut female mating members 504 formed in the corresponding mating inserts 301, 302 as recesses. When mated, apertures 313 in inserts 301, 302 are substantially aligned with lower apertures 503 positioned in the lower male mating members 502 so that a pin 304 (see Figure 3) or other suitable member, may be positioned therein to position mating inserts 310, 302 relative to each other.

Figures 5c and 5d illustrate an alternate embodiment of the mating inserts 301, 302. Figure 5c illustrates mating inserts 301, 302 removed from cage plate assembly 204 and removed from within center aperture 801 in power tong 802. As shown, inserts 301, 302 are simply sectioned and have only mating sides 505a with no mating members to hold inserts 301, 302 together.

Figure 5c illustrates gripping aperture **205** having its smallest diameter, referred to as a first dimension and marked as first dimension α in Figure 5c. Figures 5d and 11 illustrate how sections **301, 302** can be removed from within center aperture **801** and detached to allow the passage of a downhole tool **150**, having a dimension larger than first dimension α but smaller than the dimension β of center aperture **801** as best seen in Figure 8. As used herein "dimension," when used to refer to the size of an aperture shall mean the distance necessary for an object, such as downhole tool **150**, to pass therethrough. When the downhole tool **150** has passed through power tong **200**, sections **301, 302** reattach to each other using pin **304** and repositioned within center aperture **801**.

As shown in Figure 7, a ring gear **600** is positioned within power tong body on rollers **710** (see also Figure 10). Ring gear **600** comprises outer gear teeth **601** that mate with the gear teeth **702** on gear **701**, rotated by motors **103** as shown in Figure 7. Viewing Figure 6a, ring gear **600** further comprises cam follower slot **605** so that followers **330** (see Figure 10) may be positioned therein. Slot **605** has one or more slits **603, 604** configured therein which receive a pin **602**, commonly known as a reversing pin in the art. Figure 3 illustrates how reversing pin **602** engages one of two apertures **602a** formed in cage plate **203**.

When jaw assemblies **610** retract, jaw rollers **609A** roll along cam surface **607** until rollers **609A** reach a recess **608**. At this point, pin **602**, which is positioned in either slot **603, 604**, stops the relative rotation between ring gear **600** and cage plates **202, 203** so that jaw rollers **609A** do not roll further upon an adjacent cam surface **607** and re-grip the tubular. Pin **602** limits the travel of rollers **609A** along cam surface **607** when tubular is gripped, thereby preventing rollers from traveling to an adjacent neutral surface and preventing jaws **610** from crushing the tubular.

While not shown in the Figures, one modification of the present invention could include the positioning of a conventional load cell thereon. The load cell could be used to measure the torque imparted to power tong **200** relative to back-up **300** during operation of the system. For example, a load cell is first affixed to power tong **200**. A vertical pressure plate is then affixed to

back-up 300 such that the pressure plate are adjacent to the load cell. When power tong 200 applies torque to a tubular, there is a tendency for power tong 200 to rotate relative to back-up 300. This tendency to rotate causes the vertical pressure plate to load the load cell. In this manner, the torque imparted to the tubular by power tong 200 can be measured. Those skilled in the art will recognize that this is but one way to measure torque. Load cells could be mounted in numerous ways upon power tong 200 to achieve the same effect. Moreover, the measurement techniques are not limited to load cells, hydraulic or otherwise. Many alternate devices for measuring loads could be employed to determine the torque imparted on the tubular.

As used herein, "vertical" shall mean substantially along the y-axis or plane created by the y-axis shown in the Figures, while "horizontal" shall mean substantially along the x-axis or plane created by the x-axis shown in the Figures where the axes are shown.

Finally, while many parts of the present invention have been described in terms of specific embodiments, it is anticipated that still further alterations and modifications thereof will no doubt become apparent to those skilled in the art. It is therefore intended that the following claims be interpreted as covering all such alterations and modifications as fall within the true spirit and scope of the invention.

CLAIMS

I claim:

1. A closed-head power tong comprising:
   a. a power tong body;
   b. a ring gear positioned within said body and comprising at least one cam surface;
   c. a cage plate assembly comprising at least:
      i. at least two mating inserts removably positioned within at least a portion of said power tong body; and
      ii. a jaw aperture formed in at least one of said mating inserts.

2. A closed-head power tong according to claim 1 wherein said cage plate assembly further comprises a cage plate ring.

3. A closed-head power tong according to claim 1 wherein said cage plate assembly further comprises at least one jaw assembly insertable into said jaw aperture.

4. A closed-head power tong according to claim 1 wherein said mating inserts are independently formed.

5. A closed-head power tong according to claim 1 wherein said ring gear has a number of cam surfaces equal to the number of said jaw apertures.

6. A closed-head power tong according to claim 1 further comprising at least one jaw spring connected between said cage plate assembly and said jaw assembly.

7. A closed-head power tong according to claim 6 wherein said jaw spring biases said jaw assembly in a retracted position.

8. A closed-head power tong according to claim 1 wherein said mating inserts are releasably connected.

9. A closed-head power tong according to claim 1 wherein said mating inserts comprise at least one mating section, each said mating section engageable with a corresponding mating section on a corresponding mating insert.

10. A closed-head power tong according to claim 1 wherein one of said mating inserts comprises at least a male mating section and another corresponding mating insert comprises at least a female mating section corresponding to said male mating section.

11. A closed-head power tong according to claim 1 wherein said mating inserts are movably connected.

12. A closed-head power tong according to claim 1 further comprising a tapered pipe guide positioned above said power tong.

13. A closed-head power tong according to claim 1 further comprising a tapered pipe guide attached to a lower end of said mating inserts.

14. A closed-head power tong according to claim 1 further comprising a back-up.

15. A closed-head power tong comprising:

a. power tong body;

b. a ring gear positioned within said body and comprising at least one cam surface; and,

c. a cage plate assembly removably positioned at least partially within said body and configured to have a gripping aperture therein having a first dimension,

wherein said cage plate assembly is adapted to increase said gripping aperture to a dimension sufficiently sized to allow passage of an object having a corresponding dimension larger than said first dimension through said gripping aperture.

16. A method of making up or breaking one or more section of tubular members using closed head power tongs comprising a closed-head power tong comprising a power tong body, a ring gear positioned within said body and comprising at least one cam surface; and, a cage plate assembly comprising at least two mating inserts removably positioned at least partially within said body and configured to have an insert gripping aperture therein having a first dimension, whereby said inserts are removable so that said first dimension of said insert gripping aperture may be increased to a dimension sufficiently sized to allow passage of an object having a corresponding dimension larger than said first dimension of said insert gripping

aperture. and wherein at least one of said tubular members comprises a tool having a dimension greater than said first dimension of said insert gripping aperture, said method comprising the steps of:

(a) removing said cage plate assembly from said power tong body;

(b) passing said tool through said power tong body a sufficient distance so that said cage plate assembly may be repositioned at least partially within said power tong body.

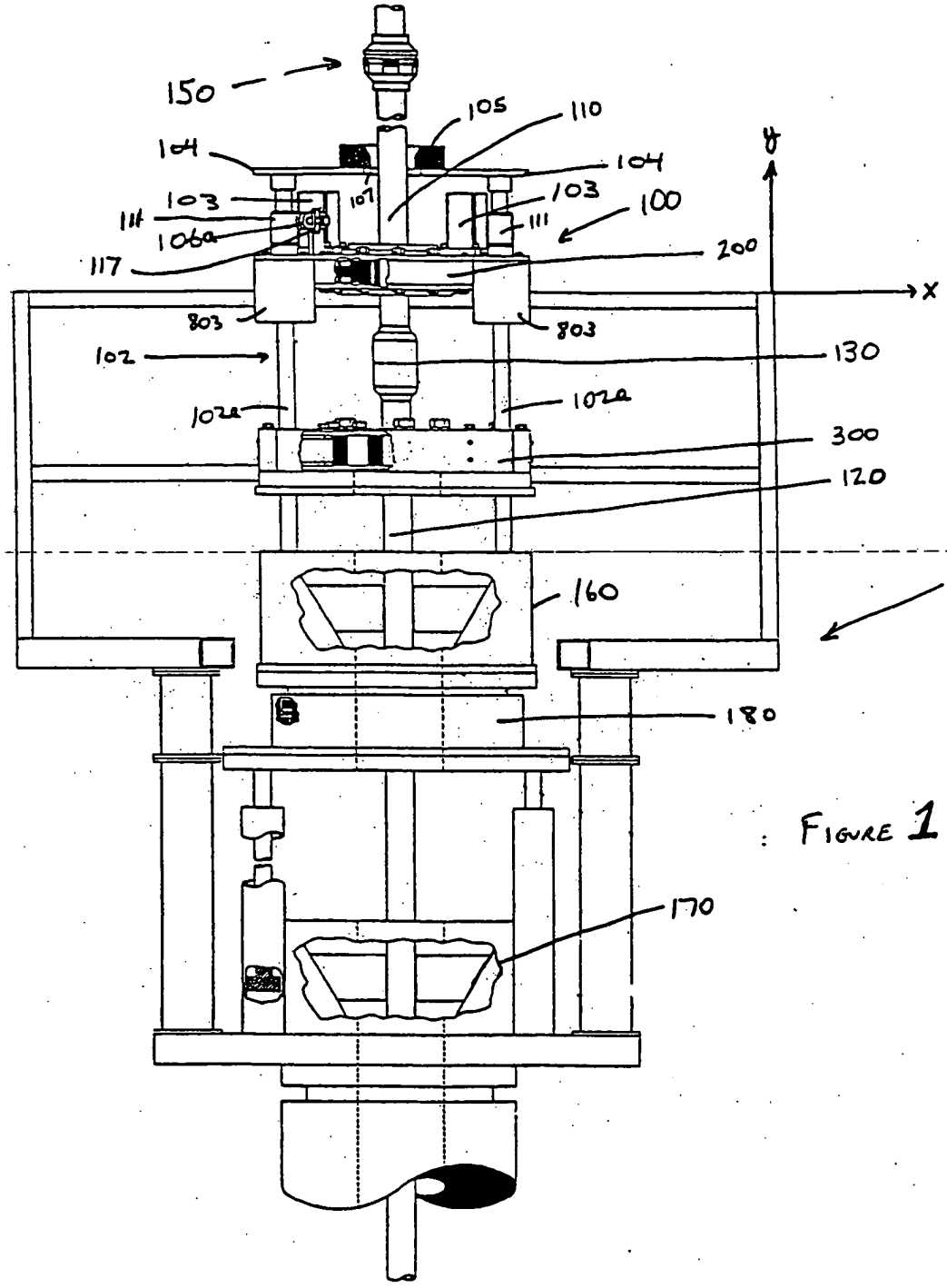
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FIGURE 1

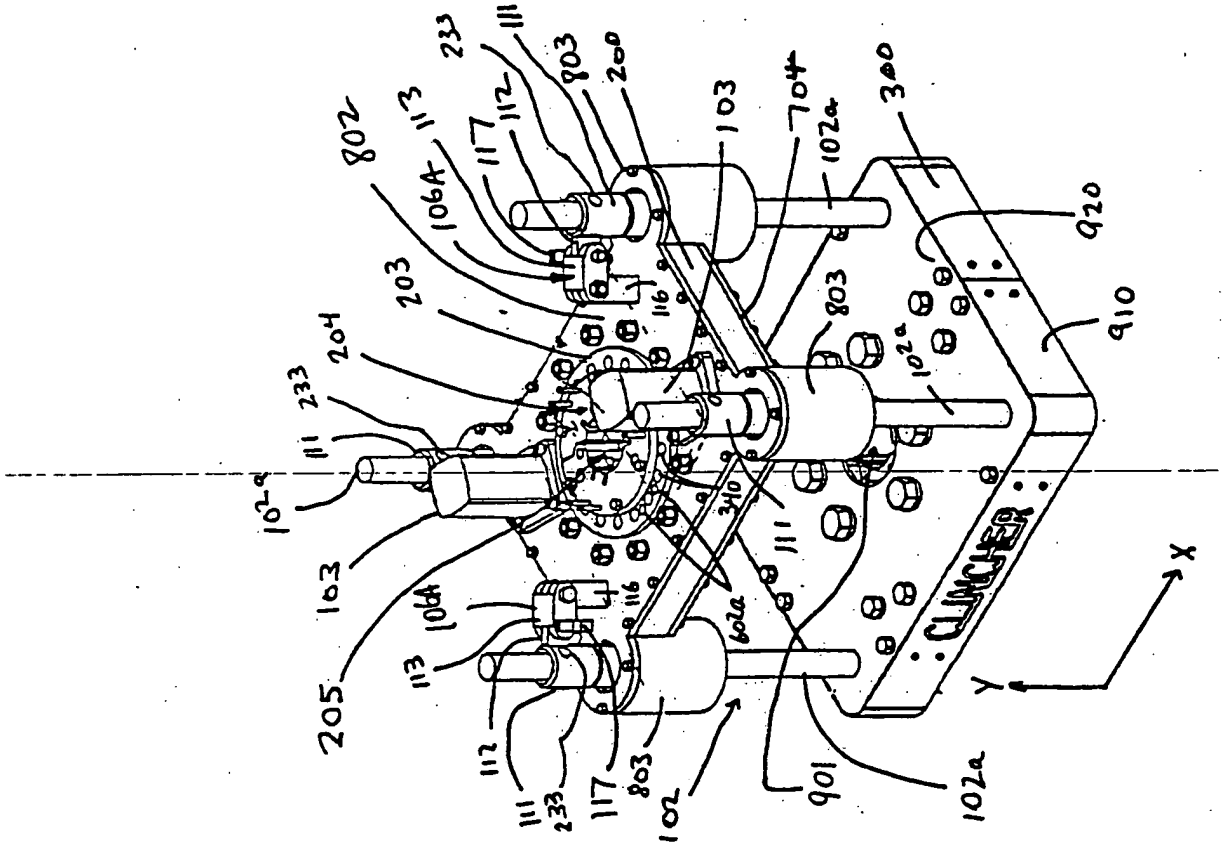

FIGURE 2B

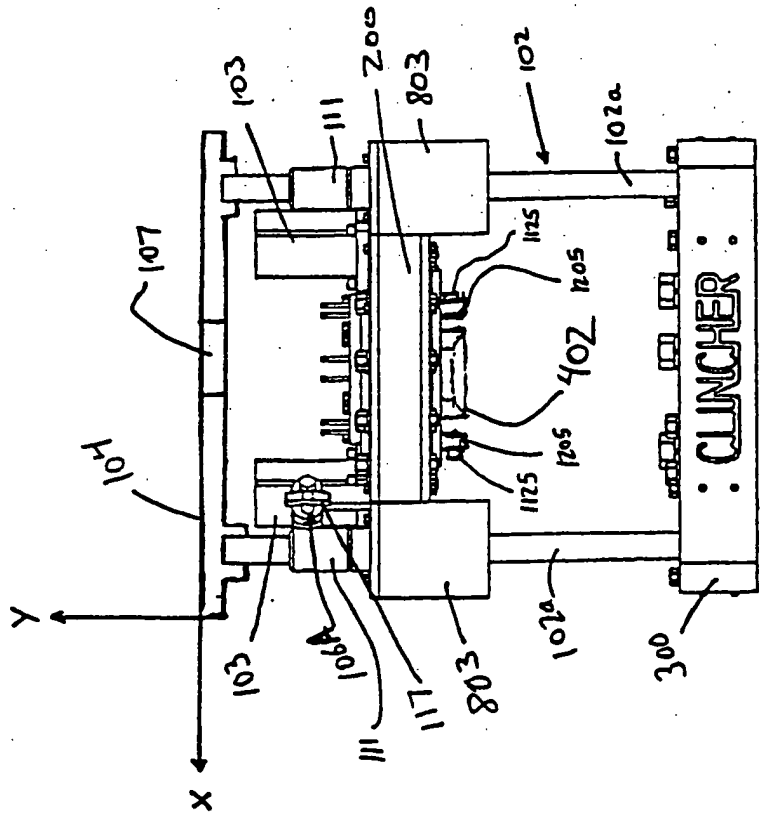

FIGURE 2A

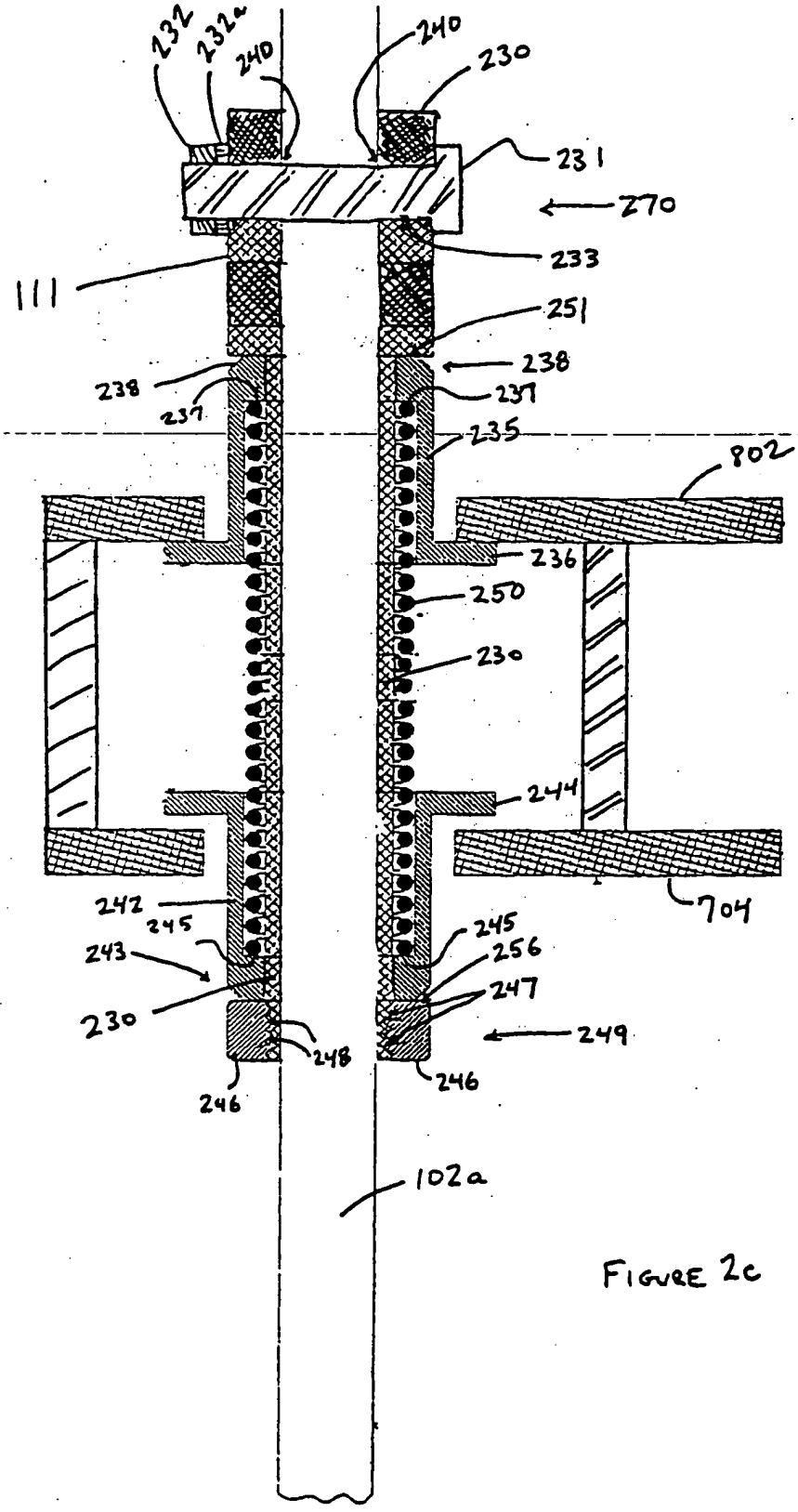
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FIGURE 2c

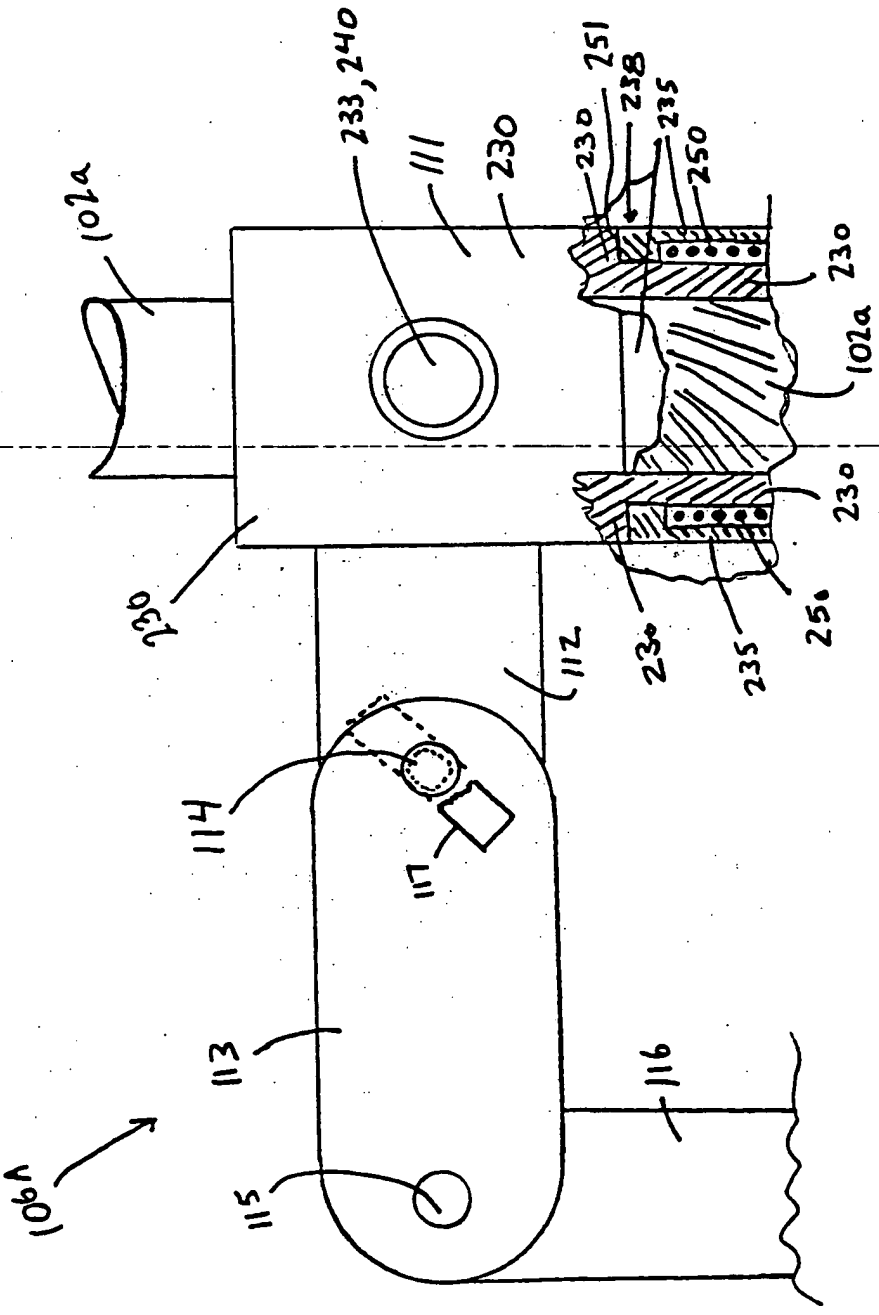
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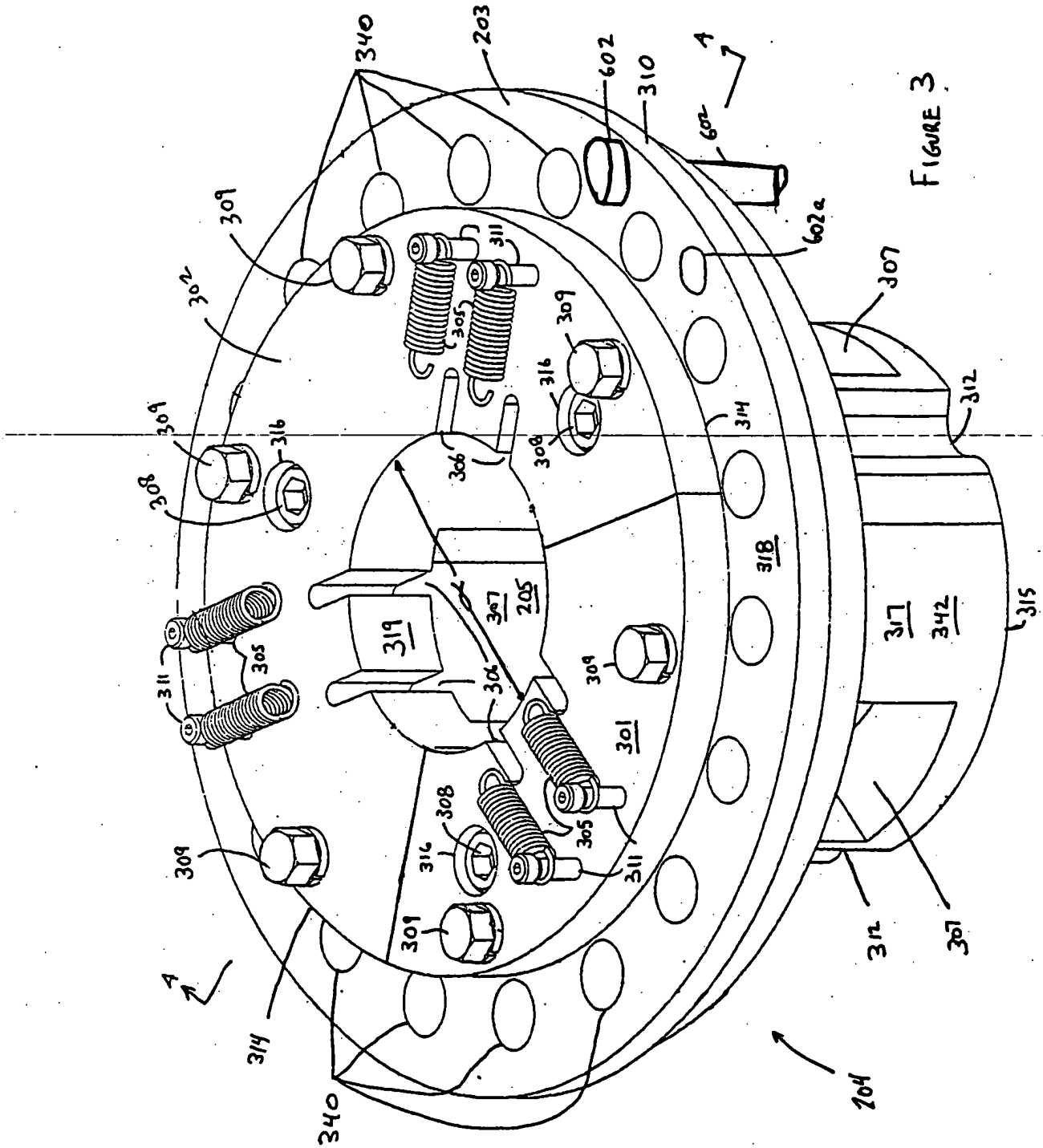
FIGURE 2d



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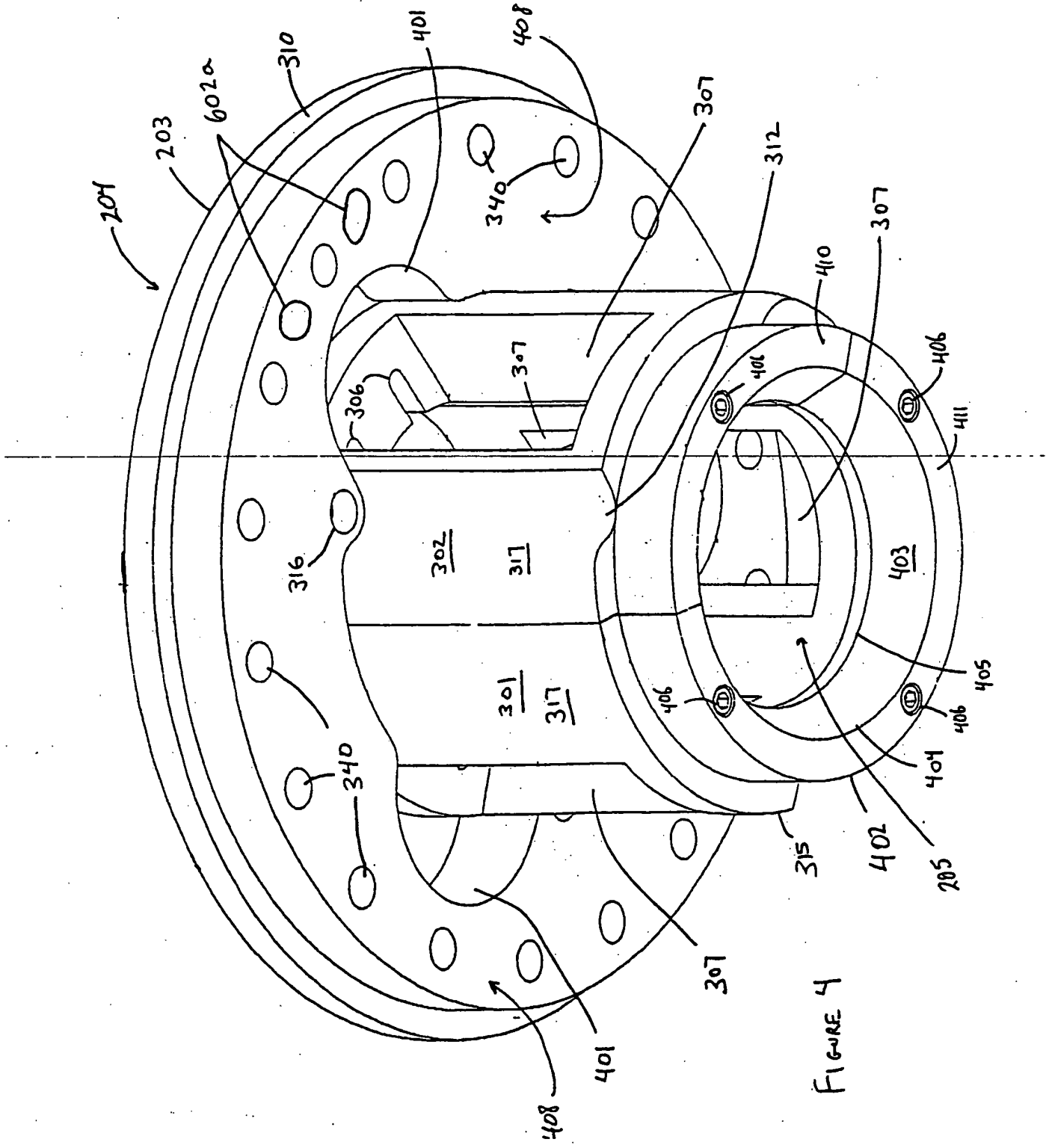
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FIGURE 4

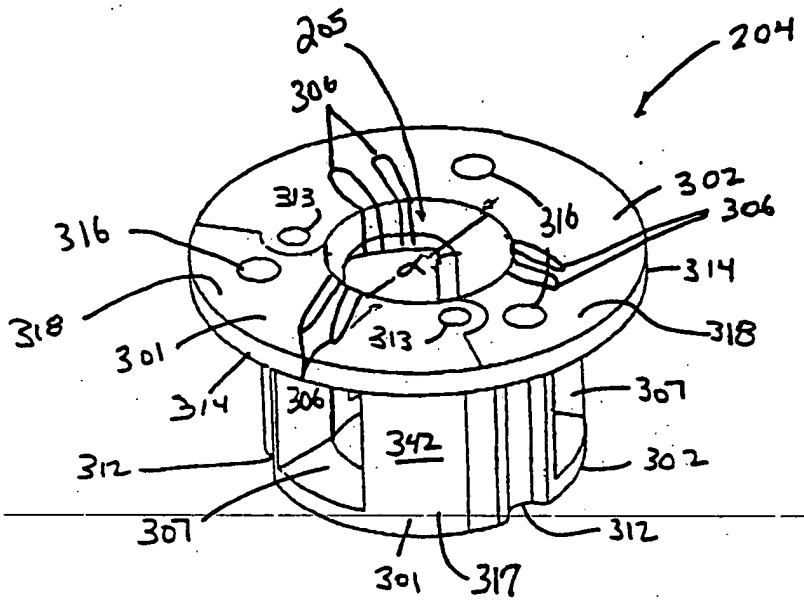


FIGURE 5a

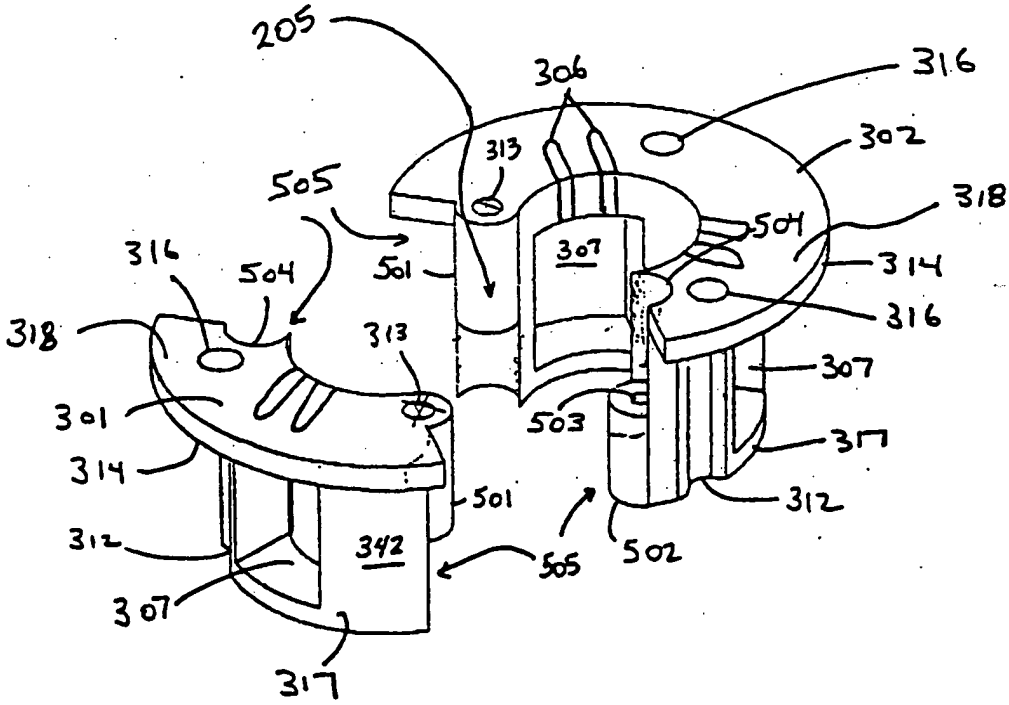


FIGURE 5b

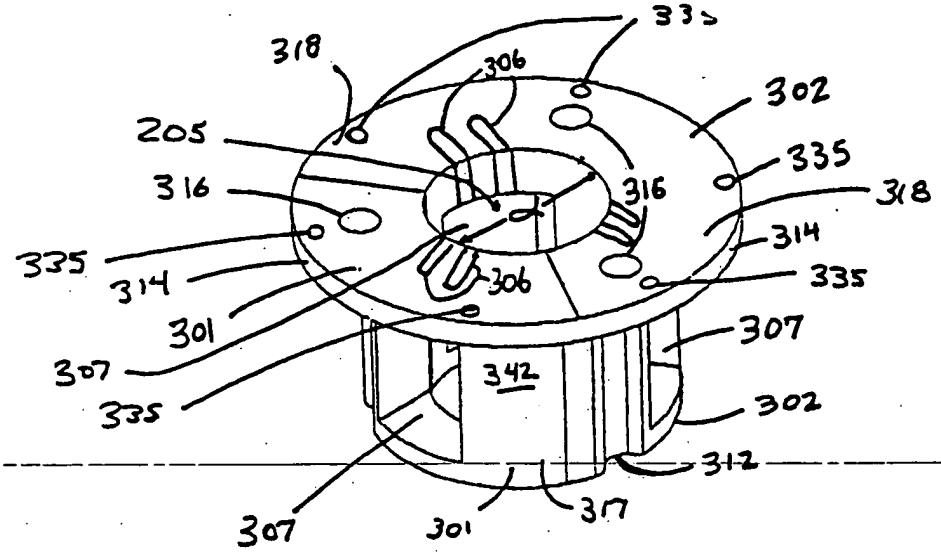


FIGURE 5c

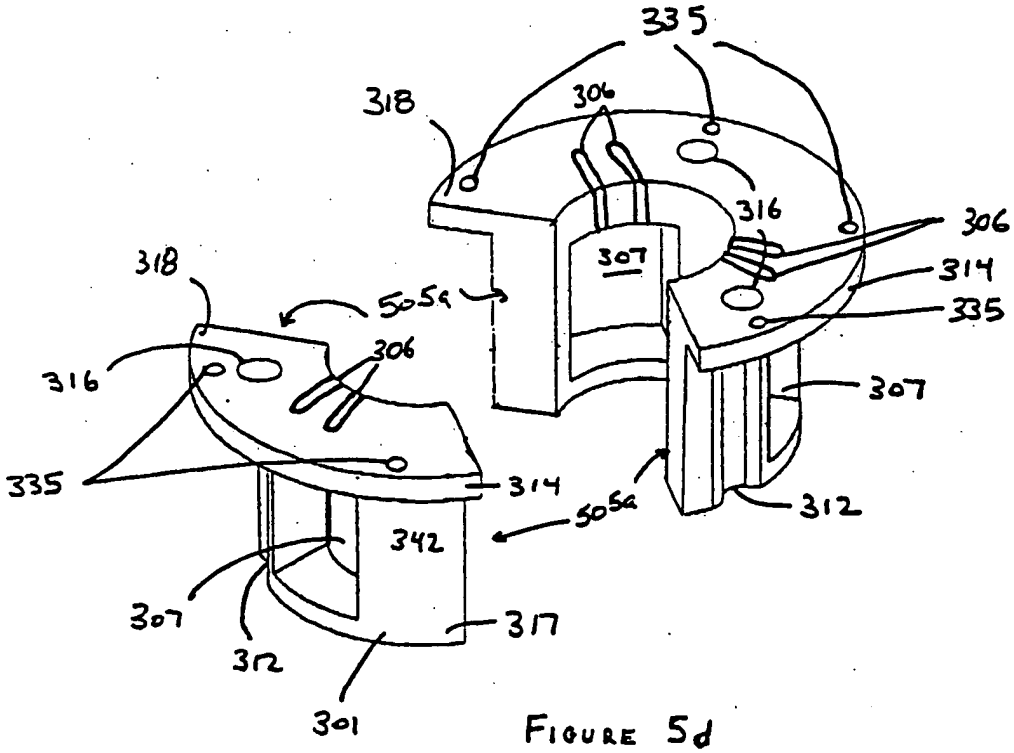


FIGURE 5d

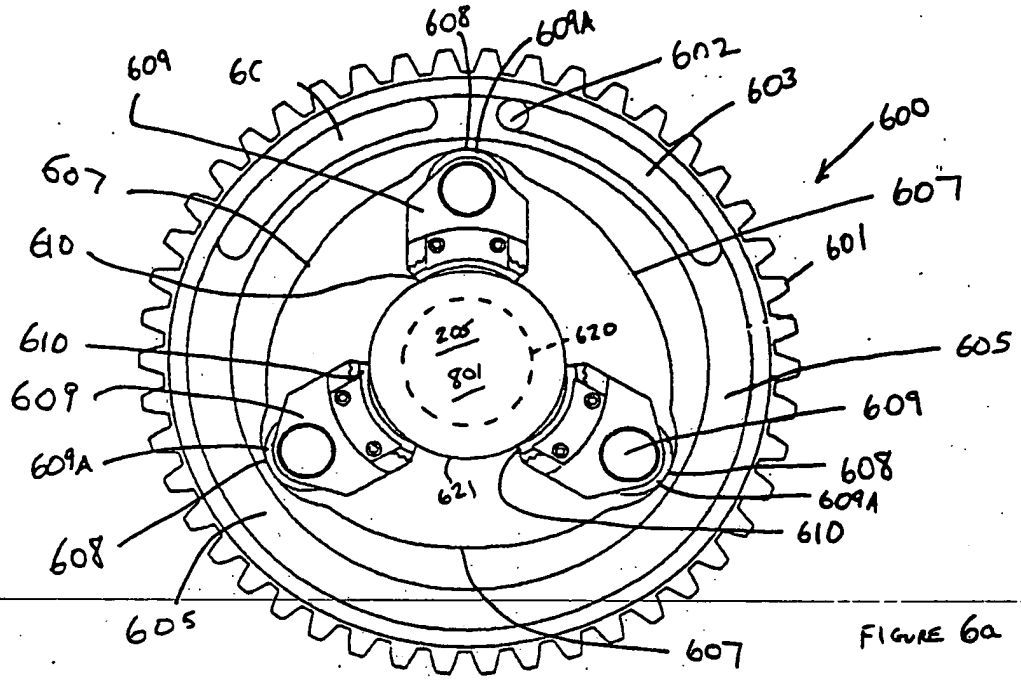


FIGURE 6a

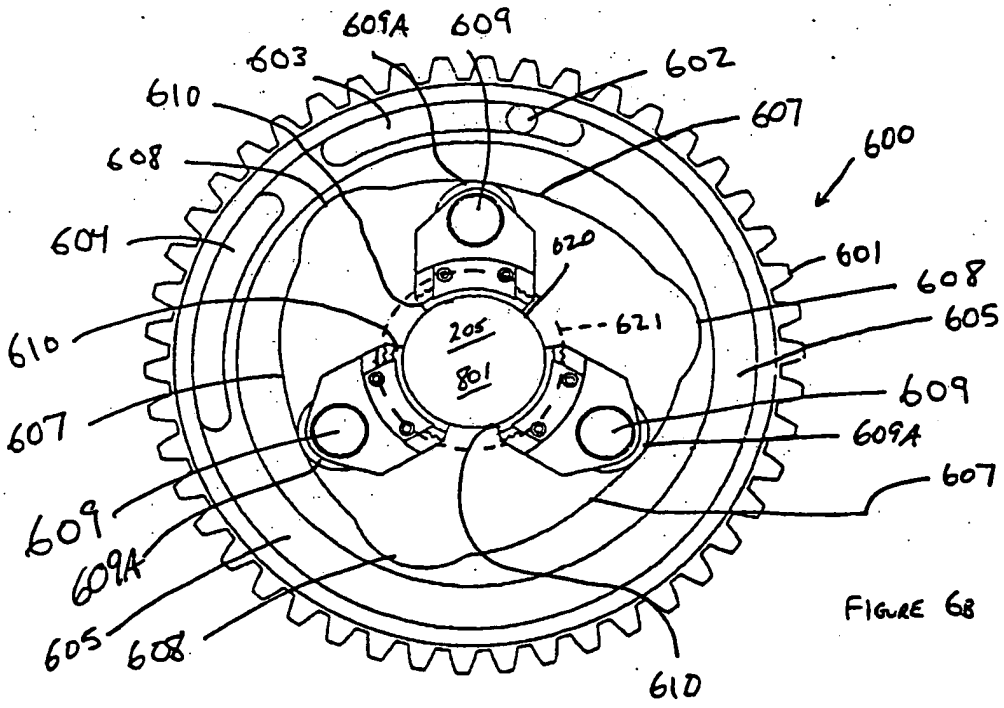
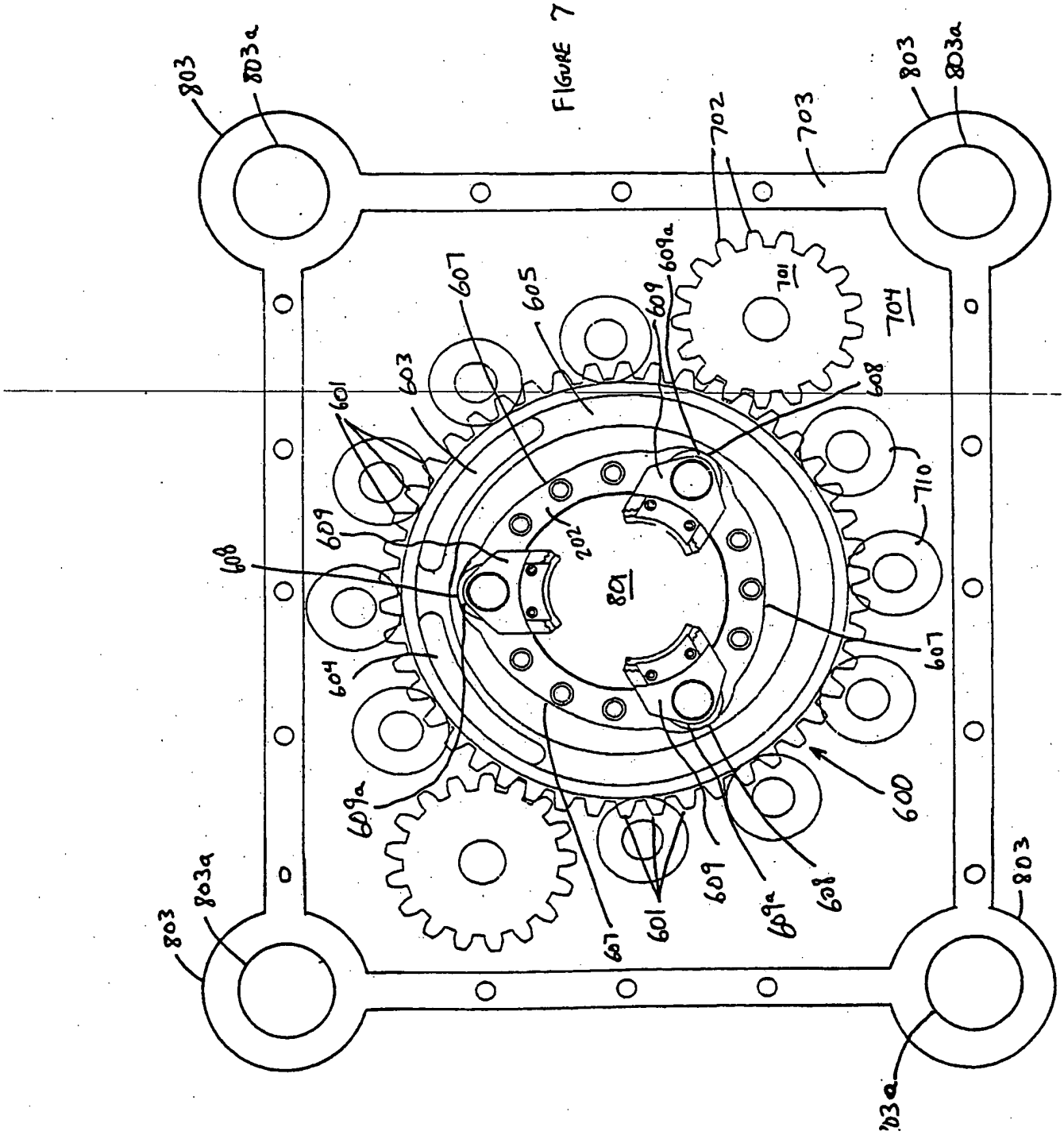


FIGURE 6B

FIGURE 7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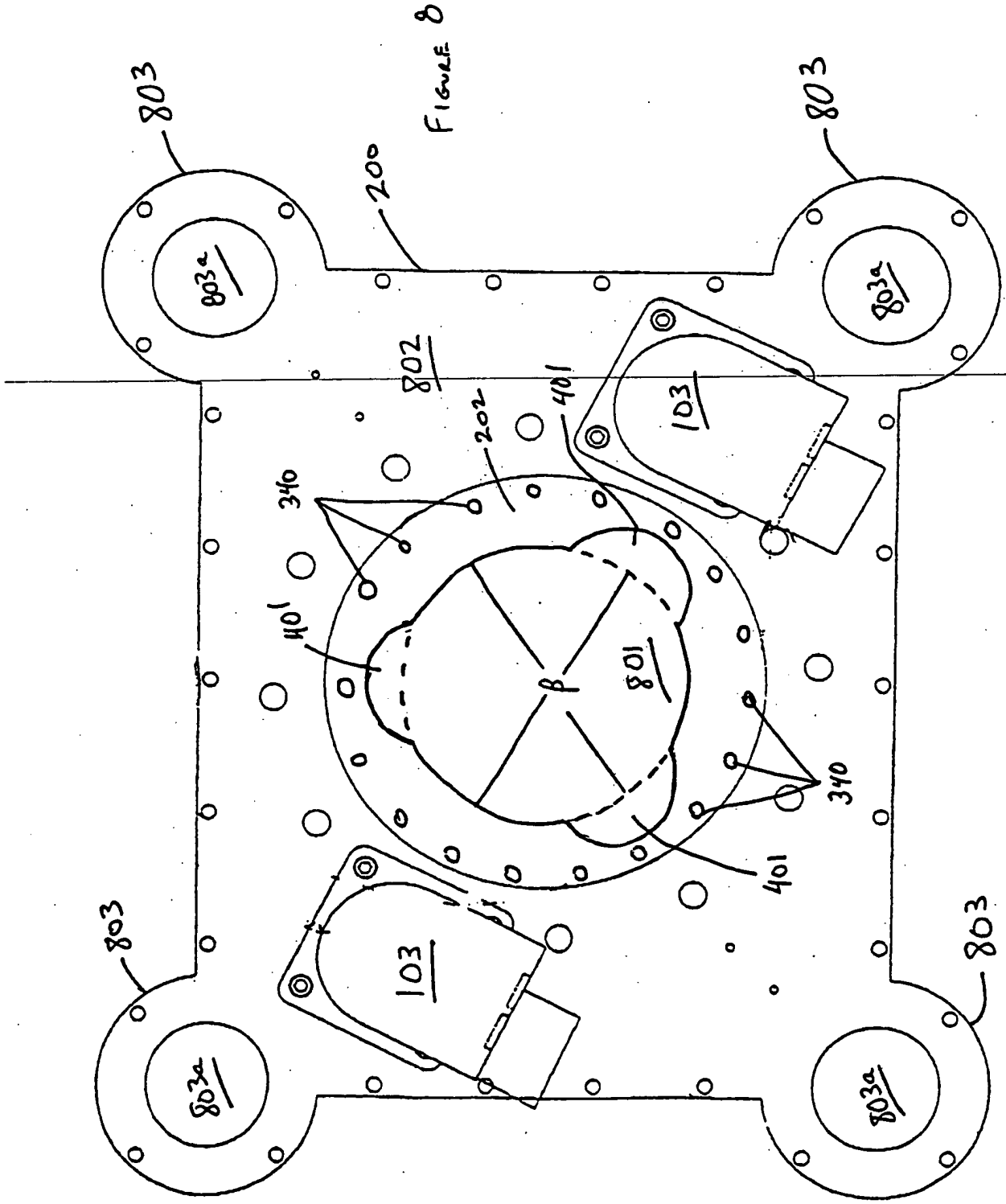
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FIGURE 8

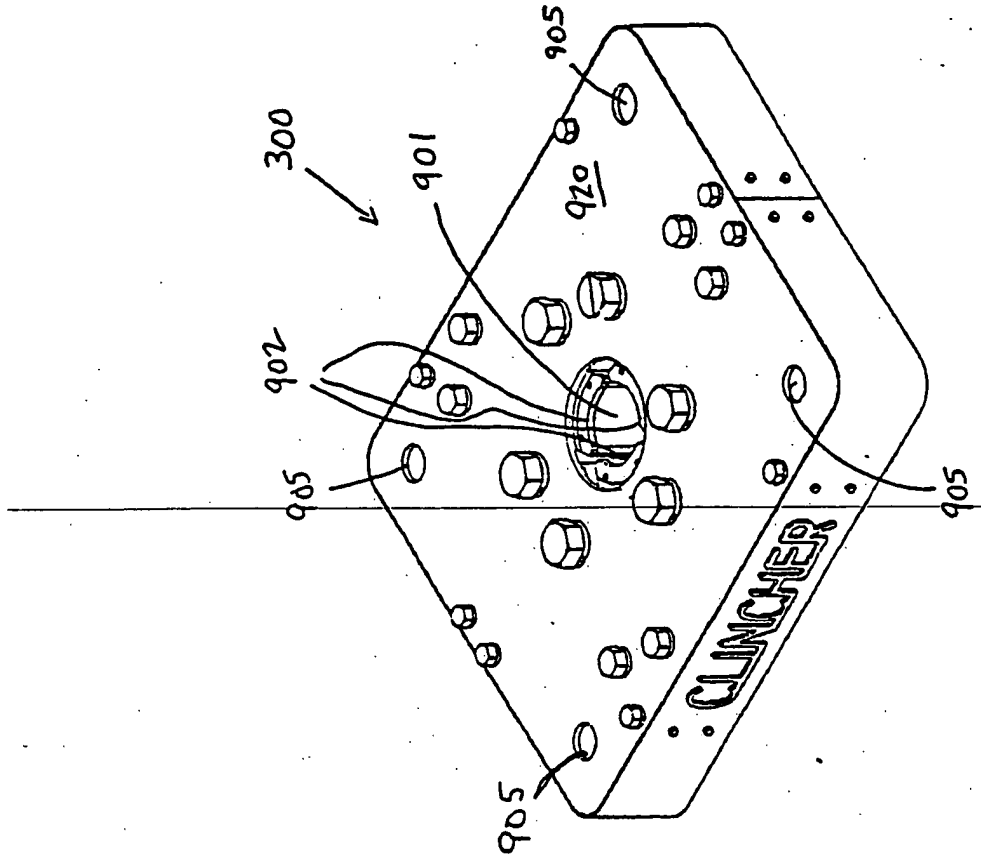

FIGURE 9B

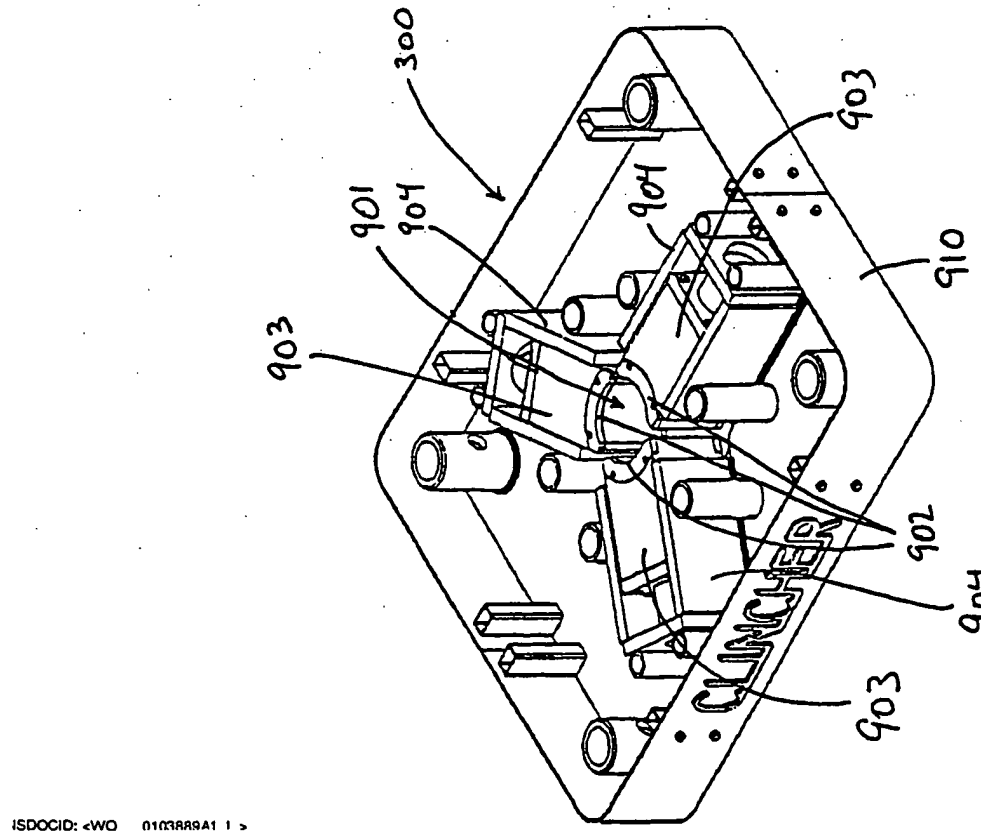

FIGURE 9A

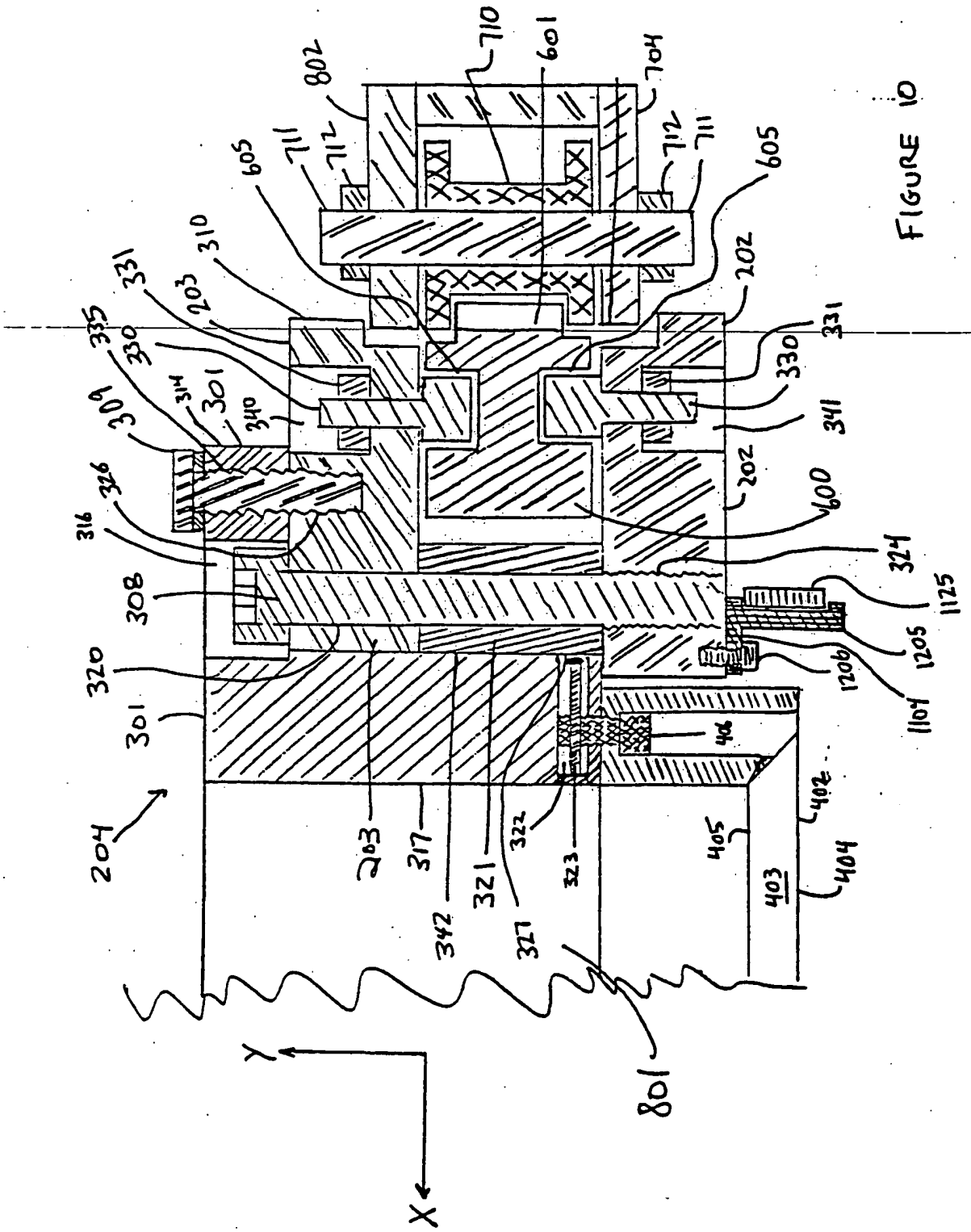

FIGURE 10

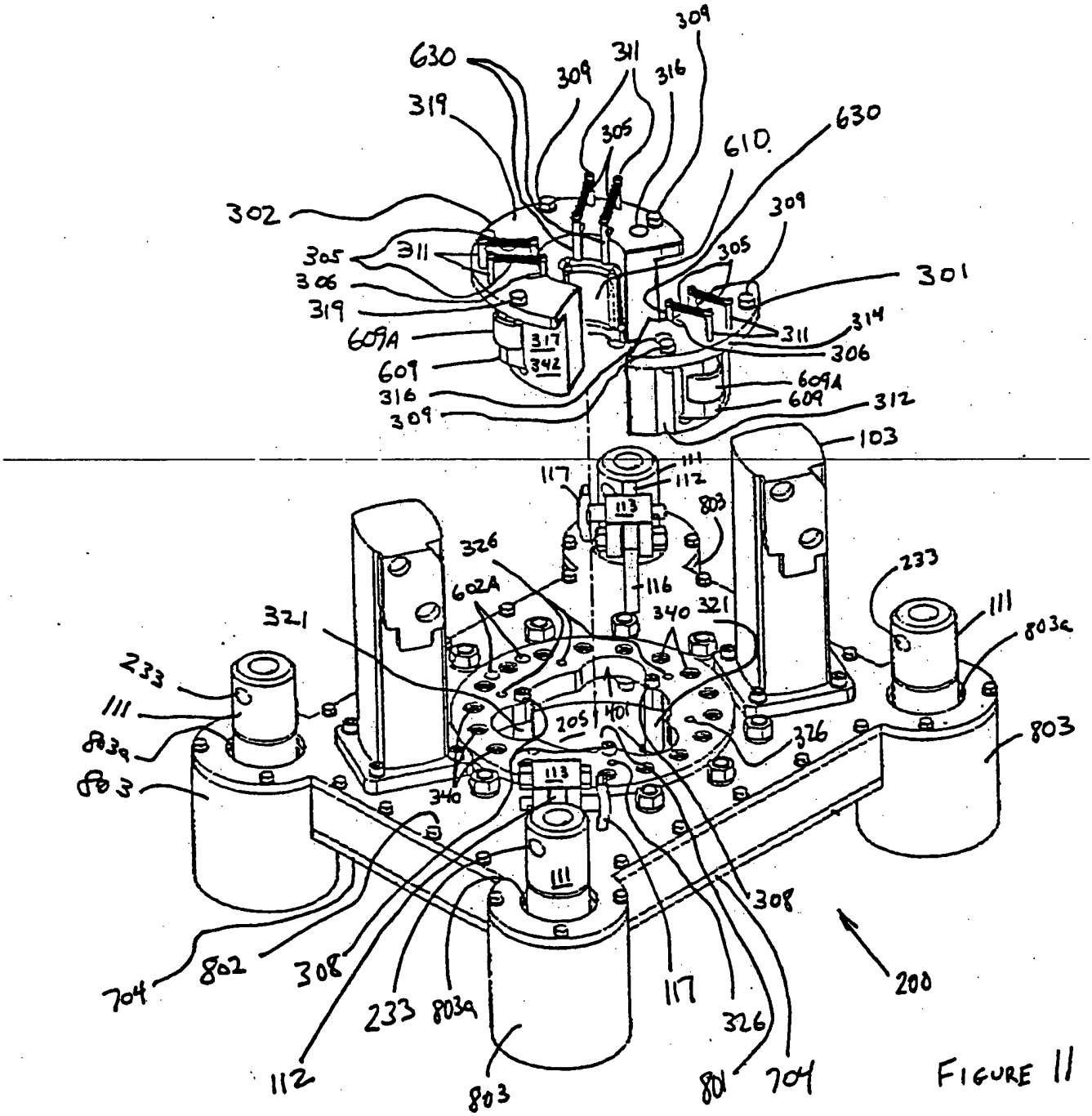
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FIGURE 11

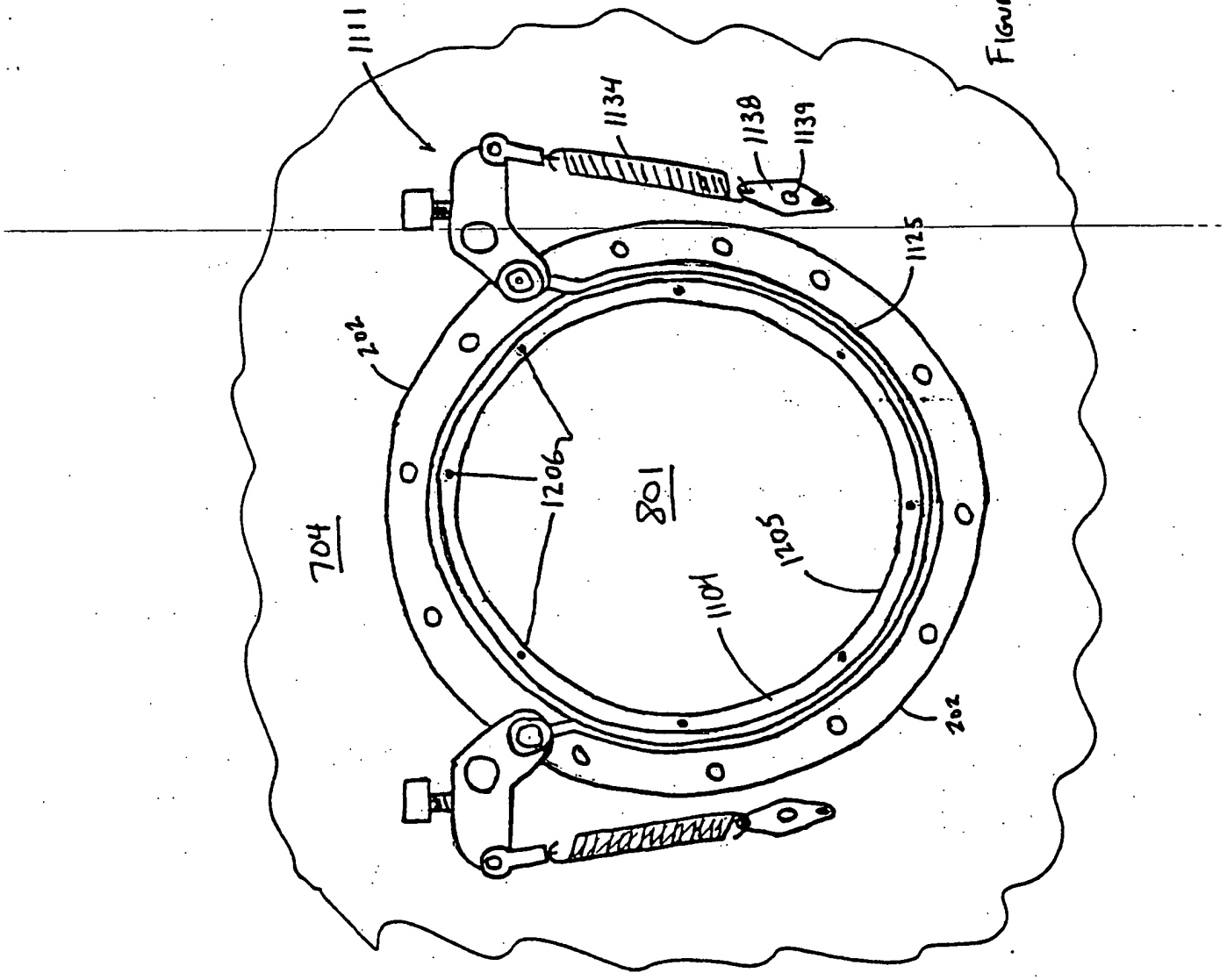

FIGURE 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/17485

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B25B 17/00
US CL :81/57.15

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 81/57.15, 57.16, 57.18, 57.19, 57.2, 57.33, 57.34

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Search term: power tongs

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,845,549 A *(BOULIGNY)* 08 December 1998, See col. 2 line 52 to col. 3, line 54.	1, 4, 8, 9, 11, 14 and 15
A	US 5,291,808 A *(BUCK)* 08 March 1994	
A	US 4,979,356 A *(VATNE)* 25 December 1990	
A	US 4,836,064 A *(SLATOR)* 06 June 1989	
A	US 4,404,876 A *(ECKEL)* 20 September 1983	

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 AUGUST 2000	19 SEP. 2000

Name and mailing address of the ISA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	TIMOTHY V. ELEY Sheila Veney Paralegal Specialist Technology Center 3700
Facsimile No. (703) 305-3230	Telephone No. (703) 308-18[illegible]

Form PCT/ISA/210 (second sheet) (July 1998)*